2474

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Date of request ~~9/14/95~~ 12/8/95   Expected receipt of document ~~10/14/95~~

Document number KDD-259   Date of document 10/12/50

Title and author (if document is unnumbered)

(This section to be completed by Document Center)

Date request received 12/12/95

Date submitted to ADC 1/5/96

Date submitted to HSA Coordinator 12/12/95

(This section to be completed by HSA Coordinator)

Date submitted to CICO 1/5/96

Date received from CICO 1/24/96

Date submitted to ChemRisk/Shonka and DOE 1/25/96

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File Index KDD-259

Date October 12, 1950

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Classification

Copy 10 of 13

Series A

Proposed Method of Fluorination Tower Operation
Short Title of Document

J. Jacobson
Author

CIRCULATION

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TO Mr. R. B. Korsmeyer

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DATE October 12, 1950

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KDD-259

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PROPOSED METHOD OF FLUORINATION TOWER OPERATION

INTRODUCTION

The experimental development of the tower reactor for UF_4 to UF_6 has indicated that the tower is capable of efficient cleanup of the UF_4 powder. No great difference has been found in the powder cleanup efficiency between countercurrent or concurrent flow of powder and gas. In countercurrent operation, it has been demonstrated that the tower reactor can also act as a fairly efficient device for cleanup of fluorine.

The problem of utilizing the tower reactor has evolved into the following: How shall the tower reactor and its auxiliary equipment be operated in order to react UF_4 and F_2 with a minimum loss of F_2, a minimum dust burden, a minimum amount of UF_6 in cold traps, and a minimum number of condenser systems?

A previous study of several schemes for employing the tower reactor (KDD-212, July 28, 1950) has been reviewed in relation to the more recent experimental data, and a more desirable method of tower operation has been devised (figure I).

Inspection of the flow sheet reveals the following:

1. 93.5% of the UF_6 produced is trapped out in the condenser.

2. There is an overall fluorine loss of 2%.

3. The total flow of gas through the cleanup section is less than 5% of the gas flow in the main reactor section.

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[signature] for ASQuist 1/24/96
Technical Information Officer Date
Oak Ridge K-25 Site

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WCX-80

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FLOW SHEET BASES

The following assumptions and operating conditions were used in preparing the flow sheet:

1. Production of UF_6 - 493 pounds per hour. The total amount of fluorine in the combined recycle and F_2 streams is 25% excess over that theoretically required for the total production of UF_6; i.e., 1.25 x 1.4 x 1.05 = 1.84# mols/hr.

2. The concentration of fluorine in the recycle and F_2 feed stream was set at 65% of the total flow of gas in the two streams.

3. The condenser pressure was set at 100 psia. and the UF_6 partial pressure was assumed to be 27 psia.

4. The total inert gas input into the system from seals, fluorine feed, powder feed, and the reaction of unconverted UO_2 and UO_2F_2 in the powder feed was set at 0.109# mols per hour. All HF input into the system is incorporated in the above figure.

5. The N_2 buffer required for the screw would not mix with the main stream, but would seek the nearest exit; i.e., cleanup outlet.

6. The F_2 feed would not mix or enter the cleanup section but would emerge in the product outlet stream.

7. A fluorine cleanup efficiency of only 50% is assumed.

8. Fluorine is supplied at 98% purity.

DISCUSSION

Figure I indicates the proposed method of operating the tower and its auxiliary equipment. The flow sheet shows the general location of gas inlet and outlet streams. The fluorine cleanup section is operated with a countercurrent flow of gas and powder while the main production section is operated concurrently.

The principal difference between this proposal and others is that there are two fluorine gas inlet streams to the tower. One stream contains undiluted fluorine, while the other stream (located above the undiluted fluorine inlet) contains the condenser outlet gas. The two streams are introduced separately to:

1. Achieve a minimum gas flow through the tower cleanup section, thus minimizing the dust burden.

2. Provide a buffer between the purge point and the pure fluorine inlet.

3. Provide a minimum loss of fluorine from the system.

4. Insure that a minimum of UF_6 is cold-trapped.

While no quantitative calculations have been made, a certain amount of qualitative information can be obtained from the flow sheet to determine the effect of changing the assumed conditions.

Fluorine Excess

If more than 25% fluorine excess is required, the following results:

1. Fluorine loss increases (relatively small).
2. UF_6 in cold trap increases (relatively small).
3. Amount of reaction occurring in cleanup section increases (relatively small).

Condenser Pressure

An increase in condenser pressure permits more UF_6 to be trapped out in the condenser. Thus less UF_6 is cold-trapped. The converse is true.

However, if the condenser pressure is dropped from 100 to 50 psia. (increasing UF_6 concentration at condenser outlet from 27 to 55%) the amount of UF_6 trapped out in the cold trap is still less than 11% of the total UF_6 produced. Thus, we have an operating method which permits us to consider the use of an Elliott compressor and still require only two cold traps on twelve-hour cycles. The effect of 50% UF_6 concentration on the reaction has not been determined and may prohibit the use of an Elliott compressor.

F_2 Cleanup Section

The flow sheet shows less than 50% cleanup of the fluorine in the tower. This is undoubtedly low. It was deliberately chosen to indicate the efficiency of the proposed operating procedure. If more than 50% of the fluorine entering the cleanup section reacts, the total fluorine loss becomes less than 2%. At the same time, the UF_6 removed in the cold trap increases to a maximum of about 9%, all other conditions remaining the same.

Turbulence in Reactor

There will always be turbulence and mixing of gas streams in the tower reactor in the reaction zone. The effect of this mixing is minimized, insofar as the cleanup section is concerned, by the addition of the recycle stream above the fluorine feed inlet. Only 15% of the recycle gas entering the tower is withdrawn at the cleanup gas outlet. The other 85% passes down the tower into the main reaction zone. The large amount of recycle gas passing down the tower acts as a buffer between the incoming undiluted fluorine and the cleanup section.

[redacted]

[redacted]

Added Equipment

The presence of two fluorine gas feed lines to the tower necessitates two gas preheaters per tower. This is one more than would normally be required. The total heating load is the same, so the net heat transfer area is the same. Additional pipe lines, control valves and instrumentation will also be required.

Control

The attached sketch, figure II, shows a proposed scheme for controlling the gas flows. The recycle streams may be set manually. The flow of incoming fluorine feed may be regulated by the fluorine concentration in the recycle streams. The purge from the system may be pressure controlled.

Flexibility

Since the flow of gas through the cleanup section is small, it may be feasible to operate only one cleanup section at a time. Changes in condenser operating pressure will have a small effect on cold trap loads.

RECOMMENDATIONS

It is suggested that a tower be operated in K-1405 in the manner suggested in this proposal to test the feasibility of the operation. Additional studies are needed for selection of optimum flows, pressures, and controls.

J. Jacobson
J. Jacobson

Approved by: J E Moore
J. E. Moore

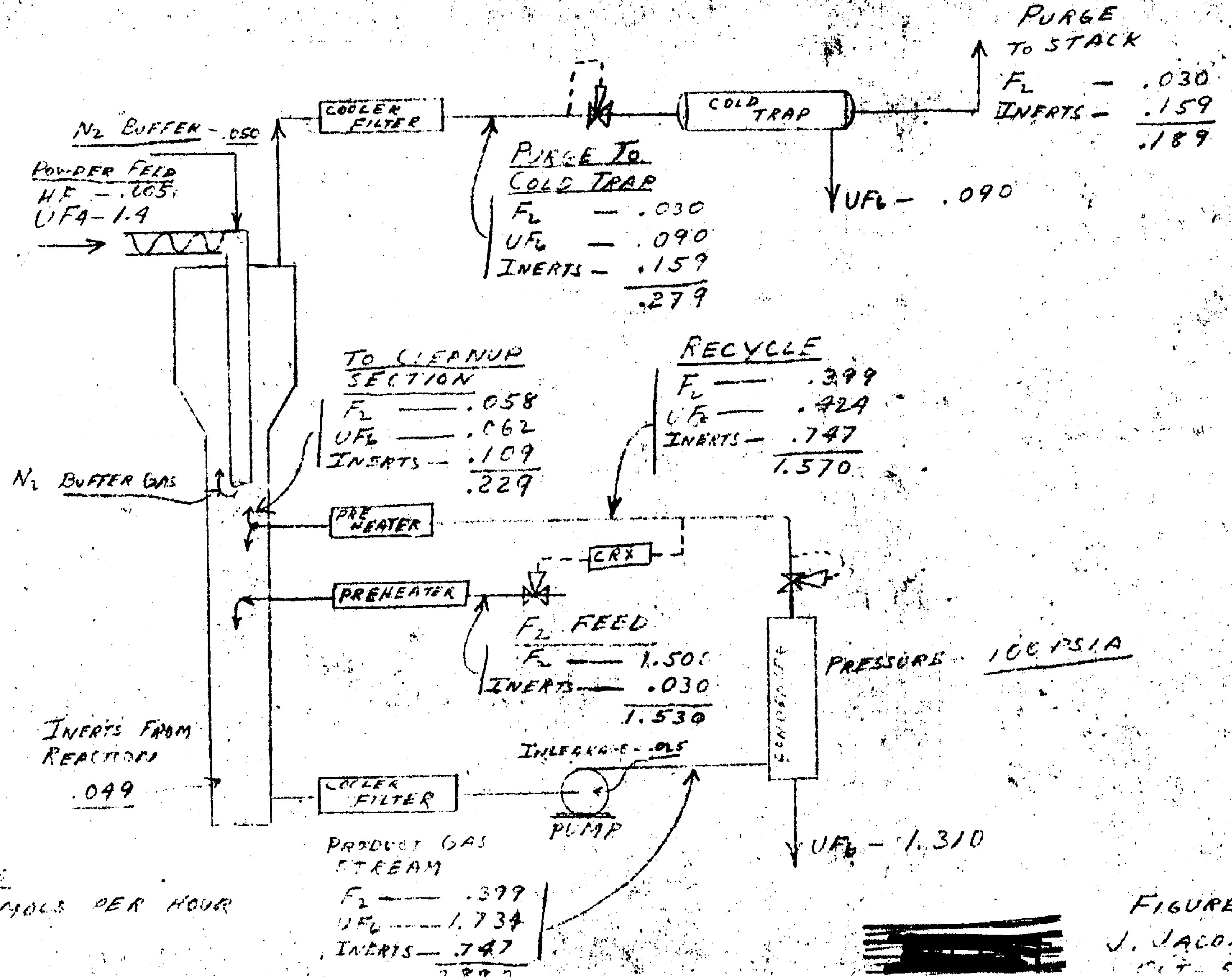
JJ:lee
Attachments

[redacted]

[redacted]

[redacted]

TOWER REACTOR FLOW SHEET



BASIS
LB MOLS PER HOUR

FIGURE I

[redacted]

J. JACOBSON

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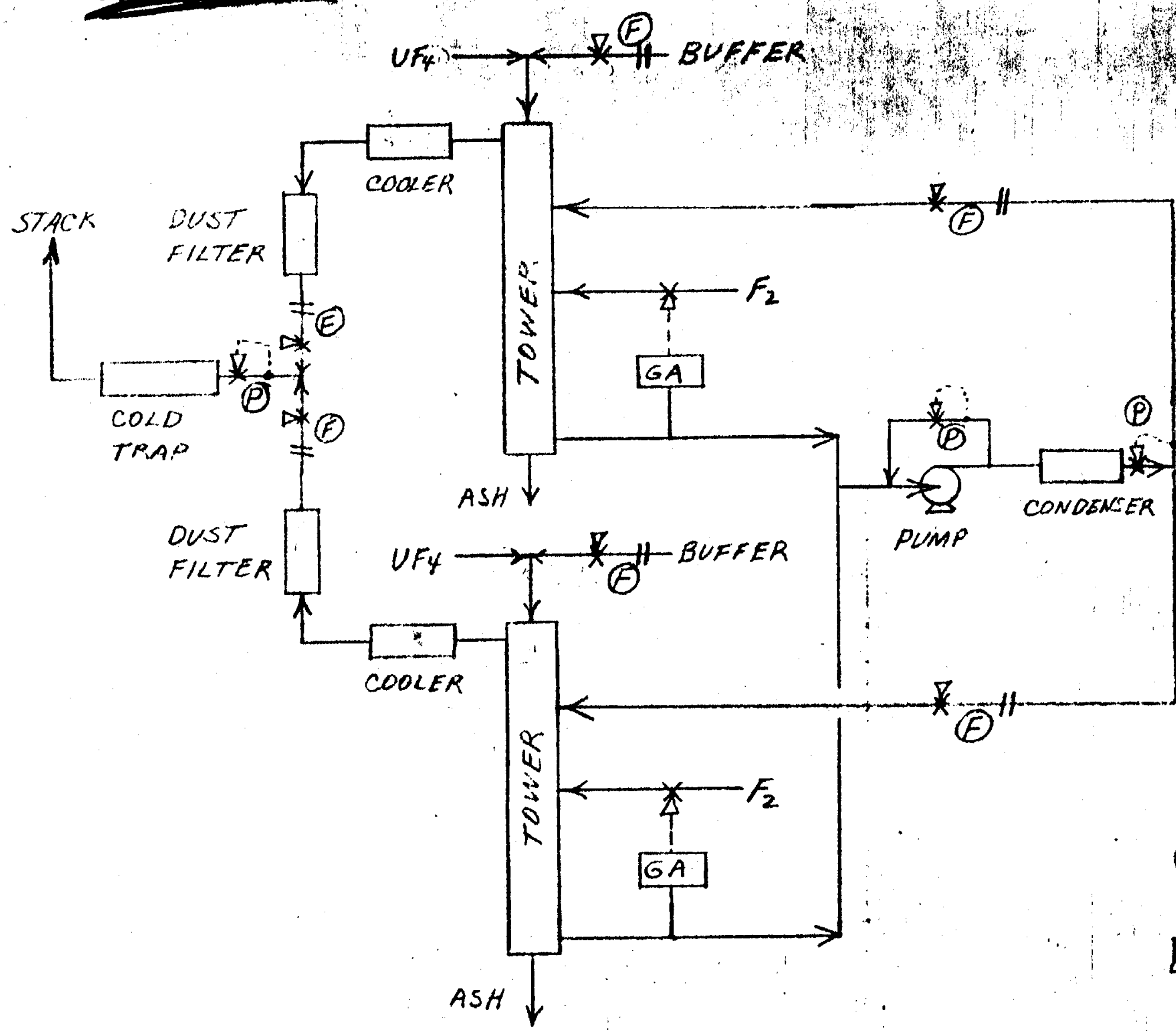

LEGEND

(F) FLOW REGULATOR

(P) PRESSURE CONTROLLER

GA GAS ANALYZER- CONTROLLER

PROPOSED FLUORINATION
TOWER GAS CONTROL

FIGURE II

10/8/50

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